

MMWR

Supplement

MORBIDITY AND MORTALITY WEEKLY REPORT

**NIOSH
Recommendations
for
Occupational Safety
and
Health Standards
1988**

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

National Institute for Occupational Safety and Health

Centers for Disease Control

Atlanta, Georgia 30333

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Centers for Disease Control.....James O. Mason, M.D., Dr. P.H.
Director

The material in this report was developed by:

National Institute for Occupational Safety and Health.....J. Donald Millar, M.D.
Director
Jeanne A. Bucsela
Consulting Editor

Division of Standards Development and
Technology Transfer.....Richard A. Lemen
Director
Richard W. Niemeier, Ph.D.
Deputy Director
William D. Wagner
Chief, Senior Review Activity
Document Development BranchBryan D. Hardin, Ph.D.
Chief

Ralph D. Zumwalde
Assistant Chief
Burt J. Cooper, Howard Ludwig
Group Leaders
Anne C. Hamilton
Writer/Editor
Barbara Carr, Brenda Ellis
Transcribers

The production of this report was coordinated in:

Epidemiology Program OfficeMichael B. Gregg, M.D.
Acting Director
Editorial ServicesR. Elliott Churchill, M.A.
Chief and Production Editor
Ruth Greenberg
Editorial Assistant

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INTRODUCTION

Acting under the authority of the Occupational Safety and Health Act of 1970 (Public Law 91-596), the National Institute for Occupational Safety and Health (NIOSH) develops and periodically revises recommendations for limits of exposure to potentially hazardous substances or conditions in the workplace. NIOSH also recommends preventive measures designed to reduce or eliminate the adverse health effects of these hazards. In formulating these recommendations, NIOSH evaluates all known and available scientific information relevant to the potential hazard. The recommendations are then published and transmitted to the Occupational Safety and Health Administration (OSHA) or the Mine Safety and Health Administration (MSHA) of the U.S. Department of Labor for use in promulgating legal standards.

NIOSH recommendations are published in a variety of documents. Criteria documents specify a NIOSH recommended exposure limit (REL) and appropriate preventive measures designed to reduce or eliminate adverse health effects.

Special hazard reviews, occupational hazard assessments, alerts, and technical guidelines are other types of NIOSH documents that complement the Institute's recommendations for standards. These documents provide safety and health assessments of specific problems associated with a given agent or hazard, and they recommend appropriate control and monitoring methods. Although these documents do not supplant the more comprehensive criteria documents, they are prepared to assist OSHA or MSHA in the formulation of regulations.

NIOSH periodically presents testimony before various Congressional committees and at regulatory hearings convened by OSHA or MSHA. The testimony always includes the current NIOSH policy concerning the hazard in question.

NIOSH Current Intelligence Bulletins (CIBs) review and evaluate new and emerging information on occupational hazards. These bulletins may draw attention to a formerly unrecognized hazard, report new data on a known hazard, or disseminate information on hazard control.

The recommendations listed in this summary are based on existing NIOSH policy as previously published in any of the forms listed above. The intent of this table is to provide a rapid reference to the most recent NIOSH REL or other recommendation for each potential hazard. The current OSHA permissible exposure limit (PEL) or standard is also presented. Unless otherwise noted in the table, the NIOSH recommendations were originally published in criteria documents.

Note to Readers:

Copies of NIOSH publications are generally available from the U.S. Government Printing Office and the National Technical Information Service. Single copies of these publications may be obtained (while the supply lasts) from

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Definitions of Abbreviations and Terms

Action level	the exposure concentration at which employers must initiate certain provisions of the NIOSH recommended standard such as periodic measurements of worker exposure, training of workers, and medical monitoring
Ca	agent recommended by NIOSH to be treated as a potential human carcinogen
CD	criteria document
CFR	Code of Federal Regulations
CIB	Current Intelligence Bulletin
CNS	central nervous system
dBA	decibels measured on the A scale, which approximates the response of the human ear
ECG	electrocardiogram
J/cm ²	joules per square centimeter
μm	micrometer
μg/m ³	micrograms per cubic meter
mg/m ³	milligrams per cubic meter
mppcf	millions of particles per cubic foot
MSHA	Mine Safety and Health Administration
mW/cm ²	milliwatts per square centimeter
NIOSH	National Institute for Occupational Safety and Health
nm	nanometer
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PCDDs	polychlorinated dibenzo- <i>p</i> -dioxins
PCDFs	polychlorinated dibenzofurans
PEL	permissible exposure limit (OSHA)
ppb	parts per billion
ppm	parts per million
REL	recommended exposure limit (NIOSH)
(Skin)	potential contribution to overall exposure by the cutaneous route, including mucous membranes and eyes
TCDD	2,3,7,8-tetrachlorodibenzo- <i>p</i> -dioxin
TWA	time-weighted average
WL	working level
WLM	working level month



NIOSH RECOMMENDATIONS FOR OCCUPATIONAL SAFETY

Potential Hazard and Source for NIOSH Recommendation*	OSHA PEL/Standard	REL†/Other Recommendations
2-Acetylaminofluorene (NIOSH testimony at OSHA hearing, September 1973)	No PEL; cancer-suspect agent; stringent workplace controls, recordkeeping, and medical monitoring required; 29 CFR 1910.1014	Ca; use 29 CFR 1910.1014
Acetylene (July 1976)	2,500 ppm (10% of lower explosive limit), 29 CFR 1915.12	No exposure >2,500 ppm (2,662 mg/m³)
Acrylamide (October 1976)	0.3 mg/m³, 8-hr TWA (Skin)	0.3 mg/m³ TWA
Acrylonitrile (January 1978; revised March 1978 as part of NIOSH testimony at OSHA hearing)	2 ppm, 8-hr TWA; 10 ppm ceiling (15 min) (Skin); 29 CFR 1910.1045	Ca; 1 ppm, 8-hr TWA; 10 ppm ceiling (15 min) (Skin)
Aldrin/dieldrin (Special Hazard Review, September 1978)	0.25 mg/m³, 8-hr TWA (Skin)	Ca; reduce exposure to lowest reliably detectable concentration
Alkanes (C5-C8) (March 1977)	All are 8-hr TWA values: pentane, 1,000 ppm (2,950 mg/m³); n-hexane, 500 ppm (1,800 mg/m³); n-heptane, 500 ppm (2,000 mg/m³); octane, 500 ppm (2,350 mg/m³)	All are TWA values: pentane, 120 ppm (350 mg/m³); hexane, 100 ppm (350 mg/m³); heptane, 85 ppm (350 mg/m³); octane, 75 ppm (350 mg/m³); mixtures should not exceed 350 mg/m³ TWA.

(continued on next page)

*Dates in parentheses indicate when the NIOSH recommendation was published or when the criteria documents were published unless otherwise noted.

†NIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

‡Health effects cited are for humans unless otherwise noted.

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NIOSH

Health Effect(s) Considered¹

Comments

Potential for cancer in humans; has produced tumors of the liver, bladder, lungs, pancreas, and skin in animals

None

Asphyxia

Check for and inform workers of contaminants such as arsine and phosphine

Skin, eye, and nervous system effects

Prevent skin and eye contact

Brain tumors, lung and bowel cancer

Periodic chest X-ray required; make first-aid and medical kits available during use; prevent skin contact

Potential for cancer in humans; has produced tumors of the lungs, liver, thyroid, and adrenal glands in animals

Aldrin/dieldrin no longer produced in U.S.; prevent skin contact

Skin and nervous system effects

None

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n²);
(³);
(³);
);

When the testimony was presented. NIOSH recommendations were originally
as noted.

Potential Hazard and Source for NIOSH Recommendation*	OSHA PEL/Standard	REL [†] /Other Recommendations
		All are ceiling values (15 min) for individual alkanes or mixtures of alkanes: pentane, 610 ppm (1,800 mg/m ³); hexane, 510 ppm (1,800 mg/m ³); heptane, 440 ppm (1,800 mg/m ³); octane, 385 ppm (1,800 mg/m ³); action level set at 200 mg/m ³ for these substances
Allyl chloride (September 1976)	1 ppm (3 mg/m ³), 8-hr TWA	1 ppm (3.1 mg/m ³) TWA; 3 ppm (9.3 mg/m ³) ceiling (15 min)
4-Aminodiphenyl (NIOSH testimony at OSHA hearing September 1973)	No PEL; cancer-suspect agent; stringent workplace controls, recordkeeping, and medical monitoring required; 29 CFR 1910.1011	Ca; use 29 CFR 1910.1011
Ammonia (July 1974)	50 ppm (35 mg/m ³), 8-hr TWA	50 ppm (34.8 mg/m ³) ceiling (5 min)
Anesthetic gases (see Waste anesthetic gases)		
Animal rendering processes (Occupational Hazard Assessment March 1981)	OSHA PELs for specific hazards are applicable	NIOSH RELs for specific hazards are applicable

NIOSH

Health Effect(s)
Considered¹

Comments

Liver, kidney, and lung
effects

Urine, blood, and pulmonary
function testing required

Bladder cancer

None

Respiratory and eye
irritation

Prevent eye contact

Mechanical injuries, burns,
heat stress, infections
from biologic agents,
chemical hazards

Guidelines have been presented
for engineering controls and
work practices to reduce injury
and illness

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Antimony
(September 1978)

0.5 mg/m³, 8-hr TWA

0.5 mg/m³ TWA

Arsenic, inorganic
(September 1974;
revised June 1975;
reaffirmed July 1982
as part of NIOSH
testimony at OSHA
hearing)

10 µg As/m³, 8-hr TWA;
29 CFR 1910.1018

Ca;
2 µg As/m³ ceiling (15 min)

Arsine
(CIB, August 1979)

0.2 mg/m³ (0.05 ppm), 8-hr
TWA

Ca;
2 µg/m³ (0.002 mg/m³)
ceiling (15 min) (see
arsenic criteria document)

Asbestos
(January 1972; revised
December 1976; revised
March 1984 as part
of NIOSH testimony at
Congressional hearing;
reaffirmed June 1984 as
NIOSH testimony at
OSHA hearing)

200,000 fibers/m³ (fibers
>5 µm long), 8-hr TWA;
action level of 100,000
fibers/m³, 8-hr TWA;
29 CFR 1910.1001

Ca;
100,000 fibers/m³ (fibers
>5µm long), 8-hr TWA
in a 400-liter air sample

Asphalt fumes
(September 1977)

None

5 mg/m³ ceiling (15 min)
measured as total particulate

Benzene
(July 1974; revised
August 1976; revised
July 1977 as part of
NIOSH testimony at
OSHA hearing; revised
March 1986 as part of
NIOSH testimony at
OSHA hearing)

1 ppm, 8-hr TWA; 5 ppm
short-term exposure
limit (15 min)

Ca;
0.1 ppm (0.32 mg/m³), 8-hr
TWA; 1 ppm (3.2 mg/m³)
ceiling (15 min)

*Dates in parentheses indicate when the NIOSH recommendation was published or was published in criteria documents unless otherwise noted.

¹NIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

²Health effects cited are for humans unless otherwise noted.

	Irritation, cardiovascular and lung effects	Periodic chest X-ray, pulmonary function testing, and electrocardiogram required
5 min)	Lung and lymphatic cancer, dermatitis	Periodic chest X-ray required
a) nent)	Sudden extensive hemolysis, cancer	Warn workers about working with arsenic compounds in presence of freshly formed hydrogen
ers /A ple	Lung cancer, mesothelioma, asbestosis	Periodic chest X-ray and pulmonary function testing required
min) articulates	Eye and respiratory irritation	Medical monitoring required; prevent skin contact
, 8-hr /m ³)	Cancer (leukemia)	Prevent skin contact

d or when the testimony was presented. NIOSH recommendations were originally

otherwise noted.

Potential Hazard and Source for NIOSH Recommendation***OSHA PEL/Standard****REL*/Other Recommendations**

Benzidine
(NIOSH testimony
at OSHA hearing,
September 1973)

No PEL;
cancer-suspect agent;
stringent workplace controls,
recordkeeping, and medical
monitoring required;
29 CFR 1910.1010

Ca;
use 29 CFR 1910.1010

Benzidine-based dyes
(Special Hazard Review,
January 1980; revised
in "Preventing Health
Hazards from...
Benzidine Congener
Dyes," January 1983)

No PEL for benzidine-
based dyes

Ca;
reduce exposure to lowest
feasible concentration;
replace with less toxic
materials

Benzoyl peroxide
(June 1977)

5 mg/m³, 8-hr TWA

5 mg/m³ TWA

Benzyl chloride
(August 1978)

5 mg/m³ (1 ppm), 8-hr TWA

5 mg/m³ ceiling (15 min)

Beryllium
(June 1972; revised
August 1977 as part
of NIOSH testimony
at OSHA hearing)

2 µg/m³, 8-hr TWA;
5 µg/m³ acceptable
ceiling; 25 µg/m³
maximum ceiling (30 min)

Ca;
do not exceed 0.5 µg Be/m³

Boron trifluoride
(December 1978)

1 ppm (3 mg/m³) ceiling

No exposure limit recom-
mended because of the abse-
nce of a reliable monitoring metho-
d; use appropriate engineering
and work-practice controls to
reduce exposure to lowest
feasible concentration

1,3-Butadiene
(CIB, February 1984)

1,000 ppm (2,200 mg/m³),
8-hr TWA

Ca;
reduce exposure to lowest
feasible concentration

NIOSH

Health Effect(s)
Considered¹

Comments

Bladder, liver, and kidney
cancer

None

Bladder cancer

Stringent workplace controls
and medical monitoring
required; urine monitoring
for benzidine suggested

Respiratory and eye
irritation, skin effects

None

Irritation, skin and eye
effects

Periodic chest X-ray and
pulmonary function testing
required

Lung cancer,
berylliosis

Periodic chest X-ray and
pulmonary function testing
required

Respiratory effects

Pulmonary function testing
required

Hematopoietic cancer,
teratogenicity,
reproductive system effects

Use appropriate engineering
and work-practice controls;
restrict access to areas where
1,3-butadiene is used

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Cadmium
(August 1976; revised
in CIB, September
1984)

Carbaryl
(September 1976)

Fume: 0.1 mg/m³, 8-hr
TWA; 0.3 mg/m³ ceiling
Dust: 0.2 mg/m³, 8-hr
TWA; 0.6 mg/m³ ceiling

5 mg/m³, 8-hr TWA

Ca;
reduce exposure to lowest
feasible concentration

5 mg/m³ TWA

Carbon black
(September 1978)

3.5 mg/m³, 8-hr TWA

3.5 mg/m³ TWA;
in presence of polycyclic
aromatic hydrocarbons:
Ca;
0.1 mg/m³ TWA

Carbon dioxide
(August 1976)

5,000 ppm (9,000 mg/m³),
8-hr TWA

10,000 ppm (18,000 mg/m³)
TWA; 30,000 ppm
(54,000 mg/m³) ceiling (10

Carbon disulfide
(May 1977)

20 ppm, 8-hr TWA; 30 ppm
acceptable ceiling; 100 ppm
maximum ceiling (30 min)

1 ppm (3 mg/m³) TWA; 10
(30 mg/m³) ceiling (15 min)

Carbon monoxide
(August 1972;
Alert, August 1984)

50 ppm (55 mg/m³), 8-hr
TWA

35 ppm (40 mg/m³), 8-hr T
200 ppm (229 mg/m³) ceiling
(no defined time)

Carbon tetrachloride
(December 1975;
revised June 1976)

10 ppm, 8-hr TWA; 25 ppm
acceptable ceiling; 200 ppm
maximum ceiling
(5 min in 4 hr)

Ca;
2 ppm (12.6 mg/m³) ceiling
(45-liter, 60-min sample)

Chlorine
(May 1976)

1 ppm (3 mg/m³) ceiling

0.5 ppm (1.45 mg/m³)
ceiling (15 min)

*Dates in parentheses indicate when the NIOSH recommendation was published or was published in criteria documents unless otherwise noted.

¹NIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

²Health effects cited are for humans unless otherwise noted.

west	Lung cancer, prostatic cancer, renal system effects	None
	Central nervous system and reproductive system effects	Warn workers of possible effects on reproductive system and permit only minimum exposure during pregnancy; prevent skin and eye contact
ic s:	Lung, cardiovascular, and skin effects; cancer of the lymphatic/bone-marrow complex when exposed to carbon black in the presence of polycyclic aromatic hydrocarbons	Periodic chest X-ray, pulmonary function testing, and ECG required
g/m ³)	Respiratory effects	None
g (10 min)		
A; 10 ppm 5 min)	Cardiovascular, central nervous system, and reproductive system effects	Advise workers of potential effects on reproductive system
4-hr TWA; ceiling	Cardiovascular effects	None
ceiling le)	Liver cancer	REL based on lowest limit of detection at time of document publication
)	Eye and respiratory irritation	Periodic chest X-ray required

or when the testimony was presented. NIOSH recommendations were originally
otherwise noted.

Potential Hazard and Source for NIOSH Recommendation*	OSHA PEL/ Standard	REL [†] /Other Recommendations
Chloroethane (CIB, August 1978)	1,000 ppm (2,600 mg/m ³), 8-hr TWA	Handle with caution in the workplace
Chloroform (September 1974; revised June 1976)	50 ppm (240 mg/m ³) ceiling	Ca; 2 ppm (9.78 mg/m ³) ceiling (45 liter, 60 min sample)
bis-Chloromethyl ether (NIOSH testimony at OSHA hearing September 1973)	No PEL; cancer-suspect agent; stringent workplace controls, recordkeeping, and medical monitoring required; 29 CFR 1910.1008	Ca; use 29 CFR 1910.1008
Chloroprene (August 1977)	25 ppm (90 mg/m ³), 8-hr TWA	Ca; 1 ppm (3.6 mg/m ³) ceiling (15 min)
Chromic acid (July 1973; revised— see Chromium(VI), December 1975)	1 mg/10 m ³ (100 µg/m ³) ceiling	25 µg/m ³ (0.025 mg/m ³) TWA; 50 µg/m ³ (0.05 mg/m ³) ceiling (15 min) as noncarcinogenic Cr(VI)
Chromium(VI) (December 1975)	1 mg/10 m ³ (100 µg/m ³) ceiling	Ca; carcinogenic Cr(VI), 1 µg/m ³ TWA; other Cr(VI), 25 µg/m ³ TWA, 50 µg/m ³ ceiling (15 min)
Chrysene (Special Hazard Review, June 1978)	0.2 mg/m ³ , 8-hr TWA	Ca; control as an occupational carcinogen

NIOSH

Health Effect(s)
Considered^a

Comments

Central nervous system effects, possible liver and/or kidney effects

Exposures should be minimized because of structural similarity to carcinogenic chloroethanes

Potential for cancer in humans; has produced cancer of the liver and kidneys in animals; central nervous system effects

None

Lung cancer

None

Lung and skin cancer, reproductive effects

Periodic chest X-ray and pulmonary function testing required; counsel pregnant workers about continuing work with chloroprene

A; Nasal ulceration

None

Lung cancer, skin ulcers, and lung irritation

Employer must demonstrate absence of carcinogenic Cr(VI); periodic chest X-ray required

Liver and skin cancer

Document also contains control recommendations for polycyclic aromatic hydrocarbons

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Coal gasification plants (September 1978)	OSHA PELs for specific hazards are applicable	NIOSH RELs for specific hazards are applicable
Coal liquefaction, (Occupational Hazard Assessment, 2 volumes, March 1981)	OSHA PELs for specific hazards are applicable	NIOSH RELs for specific hazards are applicable
Coal tar products (September 1977)	0.2 mg/m ³ , 8-hr TWA (benzene-soluble fraction); 29 CFR 1910.1002 (coal tar pitch volatiles)	Ca; 0.1 mg/m ³ TWA (cyclohexane extractable fraction)
Cobalt (Occupational Hazard Assessment, October 1981)	0.1 mg/m ³ , 8-hr TWA	NIOSH has concluded that there is insufficient evidence to warrant recommending an exposure limit
Coke oven emissions (February 1973; revised November 1975 as part of NIOSH testimony at OSHA hearing)	150 µg/m ³ , 8-hr TWA; 29 CFR 1910.1029	Ca; 0.5-0.7 mg/m ³ (500-700 µg (total particulates) as screening level
Confined spaces, working in (December 1979)	Covered under numerous OSHA regulations for general industry (29 CFR 1910)	Various recommendations, including a permit system prevent worker injury and
Cotton dust (September 1974; reaffirmed September 1983 as part of NIOSH testimony at OSHA hearing)	Lint-free respirable cotton dust in yarn manufacturing and cotton washing operations, 200 µg/m ³ , 8-hr TWA; lint-free respirable cotton dust in textile mill waste house operations or (continued on next page)	200 µg/m ³ lint-free cotton dust

^aDates in parentheses indicate when the NIOSH recommendation was published or was published in criteria documents unless otherwise noted.

^bNIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

^cHealth effects cited are for humans unless otherwise noted.

ic	Various effects depending on substances present; skin cancer	Extensive work-practice and control procedures recommended.
ic	Various effects depending on substances present; skin cancer	Extensive work-practice and control procedures recommended.
hexane-	Lung and skin cancer	Includes coal tar, creosote, and coal tar pitch; pulmonary function testing and periodic chest X-ray required
that	Dermatitis, potential for pulmonary fibrosis	Includes recommendations for engineering controls, work practices, protective equipment, worker education, and environmental and medical monitoring
recom- limit		
0 µg/m ³)	Lung cancer, bladder cancer	Periodic chest X-ray required; use work practices to minimize exposure to emissions
tions, stem to and death	Injury and death	Check for oxygen-deficient atmospheres and toxic gases before entry
otton	Pulmonary disease (byssinosis)	Pulmonary function testing required

**Potential Hazard and
Source for NIOSH
Recommendation***

**OSHA PEL/
Standard**

**REL*/Other
Recommendations**

	lower-grade washed cotton in yarn manufacturing, 500 $\mu\text{g}/\text{m}^3$, 8-hr TWA; lint-free respirable cotton dust in slashing and weaving processes, 750 mg/m^3 ; 29 CFR 1910.1043	
	Cotton waste processing operations of waste recycling (sorting, blending, cleaning, and willowing) and garmenting, 1 mg/m^3 ; 29 CFR 1910.1000	
Creosol (February 1978)	5 ppm (22 mg/m^3), 8-hr TWA (Skin)	2.3 ppm (10 mg/m^3) TW
DDT (Special Hazard Review, September 1978)	1 mg/m^3 , 8-hr TWA (Skin)	Ca; lowest reliably detectable concentration (currently 0.5 mg/m^3 TWA by NIOSH validated method)
2,4-Diaminoanisole and its salts (CIB, January 1978)	None	Ca; reduce exposure to lowest feasible concentration
p-Dianisidine-based dyes (joint NIOSH/OSHA health hazard alert, December 1980)	None	Ca; handle with caution in workplace and minimize exposures

NIOSH

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ns	Health Effect(s) Considered ¹	Comments
3) TWA	Skin, liver, kidney, and pancreas effects	Applies to mixtures of cresols and cresylic acid; prevent skin and eye contact; possible delayed effects
ectable rently y NIOSH-	Potential for cancer in humans; has produced tumors of the liver, lungs, and lymphatic system in animals	Prevent skin contact
o lowest tion	Potential for cancer in humans; has produced tumors of the thyroid, skin, and lymphatic system in animals	Prevent skin contact; engineering and work-practice controls are recommended
on in the minimize	Potential for cancer in humans; has produced tumors of the bladder, stomach, and mammary glands in animals	Substitute less toxic dyes wherever possible

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Dibromochloropropane
(January 1978)

1 ppb, 8-hr TWA;
29 CFR 1910.1044

10 ppb (0.1 mg/m³) TWA
(NIOSH recommendation
superseded by OSHA standard
promulgated in 1978)

3,3'-Dichlorobenzidine
(NIOSH testimony
at OSHA hearing,
September 1973)

No PEL;
cancer-suspect agent;
stringent workplace controls,
recordkeeping, and medical
monitoring required;
29 CFR 1910.1007

Ca;
use 29 CFR 1910.1007

1,1-Dichloroethane
(CIB, August 1978)

100 ppm (400 mg/m³),
8-hr TWA

Handle with caution in the
workplace

Dieldrin
(see Aldrin/dieldrin)

Diesel exhaust
(CIB, July 1988)

OSHA and MSHA PELs for
individual components of
diesel exhaust are applicable

Ca;
reduce exposure to lowest
feasible concentration

Di-2-ethylhexyl
phthalate (DEHP)
(Special Hazard
Review, March 1983)

5 mg/m³, 8-hr TWA

Ca;
reduce exposure to lowest
feasible concentration

Diisocyanates
(September 1978)

Toluene diisocyanate (TDI),
0.02 ppm (0.14 mg/m³)
ceiling; diphenylmethane
diisocyanate (MDI),
0.02 ppm (0.2 mg/m³)
ceiling

All values are in µg/m³ and
all ceilings are 10 min (each
value is equivalent to 5 ppb
TWA and 20 ppb ceiling):
TDI, 35 TWA, 140 ceiling;
MDI, 50 TWA, 200 ceiling;
hexamethylene diisocyanate
(continued on next page)

*Dates in parentheses indicate when the NIOSH recommendation was published or was published in criteria documents unless otherwise noted.

[†]NIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

[‡]Health effects cited are for humans unless otherwise noted.

WA
ion
standard

Sterility, renal
and liver effects

Regulated by OSHA as
a carcinogen

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Potential for cancer in
humans; has produced tumors
of the liver, bladder, and
lungs in animals

None

n the

Central nervous system
effects, possible liver
and/or kidney damage

Exposures should be minimized
because of structural similarity
to carcinogenic chloroethanes

lowest
a

Lung cancer, respiratory
system effects, eye
irritation

Typical components of diesel
exhaust include carbon dioxide,
carbon monoxide, formaldehyde,
nitrogen dioxide, nitric oxide,
sulfur dioxide, respirable dust,
and polynuclear aromatic
hydrocarbons

MMWR

lowest
n

Potential for cancer in
humans; has produced liver
tumors in animals

DEHP (widely used in the
quantitative fit testing of
respirators) should be replaced
with less toxic material such
as refined corn oil

n³ and
n (each
5 ppb
ing);
ing;
cyanate
age]

Respiratory effects and
sensitization, pulmonary
irritation

Periodic chest X-ray and
pulmonary function testing
required

or when the testimony was presented. NIOSH recommendations were originally
otherwise noted.

Potential Hazard and Source for NIOSH Recommendation*

OSHA PEL/Standard

REL[†]/Other Recommendations

4-Dimethylaminoazobenzene
(NIOSH testimony at OSHA hearing, September 1973)

No PEL;
cancer-suspect agent;
stringent workplace controls,
recordkeeping, and medical
monitoring required;
29 CFR 1910.1015

(HDI), 35 TWA, 140 ceiling;
naphthalene diisocyanate (NDI),
40 TWA, 170 ceiling;
isophorone diisocyanate (IPDI),
45 TWA, 180 ceiling;
dicyclohexylmethane 4,4'-diisocyanate (hydrogenated MDI),
55 TWA, 210 ceiling. Control
other diisocyanates to 20 ppb
ceiling and 5 ppb TWA

Ca;
use 29 CFR 1910.1015

Dinitro-ortho-cresol
(February 1978)

0.2 mg/m³, 8-hr TWA (Skin)

0.2 mg/m³ TWA

Dinitrotoluenes
(CIB, July 1985)

1.5 mg/m³, 8-hr TWA (Skin)

Ca;
reduce exposure to lowest
feasible concentration

Dioxane
(September 1977)

100 ppm (360 mg/m³), 8-hr
TWA (Skin)

Ca;
1 ppm (3.6 mg/m³) ceiling
(30 min)

Dioxin
(see 2,3,7,8-Tetra-
chlorodibenzo-*p*-dioxin)

NIOSH

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Health Effect(s)
Considered^a

Comments

; (NDI),

(PDI),

diiso-
(DI),
rol
ppb

Potential for cancer in
humans; has produced tumors
of the liver and bladder
in animals

None

Central nervous system
and metabolic effects

Blood and urine monitoring
required; prevent skin and eye
contact; possible delayed effects

Potential for cancer in
humans; has produced
tumors of the liver, skin,
and kidneys in animals;
reproductive system effects

Prevent skin contact

Potential for cancer in
humans; has produced tumors
of liver, lungs, and nasal
cavity in animals; effects
on liver and kidney

Blood and urine testing required;
prevent skin contact

MMWR

August 26, 1988

Electrical energy and electrocutions (Alerts, December 1984, July 1985, July 1986, October 1986, December 1986, December 1987; revised in written comments to OSHA, February 1988)

Electrical protective devices, 29 CFR 1910.137; design safety standards for electrical systems, 29 CFR 1910.302-330; safety-related work practices, 29 CFR 1910.331-360; safety related maintenance, 29 CFR 1910.361-380; safety requirements for special equipment, 29 CFR 1910.381-398

Numerous work practice control recommendations reducing the risk of electrocutions and related injuries

Elevated workstations, emergency egress from (December 1975)

Sections under Subpart E, Means of Egress, General Industry Standards, and Subpart R, Special Industries (29 CFR 1910.261)

Various recommendations concerning means and availability of egress

Epichlorohydrin (September 1976; revised in CIB October 1978)

5 ppm (19 mg/m³), 8-hr TWA

Ca; minimize occupational exposure

2-Ethoxyethanol (see Glycol ethers)

Ethyl chloride (see Chloroethane)

Ethylene dibromide (August 1977; revised November 1983; reaffirmed February 1984 as part of NIOSH testimony at OSHA hearing)

20 ppm, 8-hr TWA; 30 ppm acceptable ceiling; 50 ppm maximum peak (5 min)

Ca; 0.045 ppm (0.38 mg/m³) 8-hr TWA; 0.13 ppm (1 mg/m³) ceiling (15 min)

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¹NIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

²Health effects cited are for humans unless otherwise noted.

actice and
dations for
f
related

Injury and death

Prompt emergency medical care can be lifesaving for workers who have contacted electrical energy; immediate cardiopulmonary resuscitation followed by advanced cardiac life support has been shown to save lives

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ications
and
es

Trauma and injury

None

onal

Respiratory cancer; mutagenesis; reproductive, skin, kidney, liver, and respiratory effects

Prevent skin contact

MMWVR

(g/m³),
m

Potential for cancer in humans; mutagenesis; damage to skin, eyes, heart, liver, spleen, and reproductive, respiratory, and central nervous systems

Warn workers of potential for reproductive abnormalities and cancer; hazardous liquid; prevent skin contact

ed or when the testimony was presented. NIOSH recommendations were originally

s otherwise noted.

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Potential Hazard and Source for NIOSH Recommendation*

OSHA PEL/Standard

REL[†]/Other Recommendations

Ethylene dichloride (March 1976; revised in CIB April 1978; revised September 1978)

50 ppm, 8-hr TWA; 100 ppm acceptable ceiling; 200 ppm maximum ceiling (5 min in 3 hr)

Ca;
1 ppm (4 mg/m³) TWA; 2 ppm (8 mg/m³) ceiling (15 min);

Ethyleneimine (NIOSH testimony at OSHA hearing, September 1973)

0.5 ppm (1 mg/m³), 8-hr TWA (Skin); 29 CFR 1910.1012

Ca;
use 29 CFR 1910.1012

Ethylene oxide (Special Hazard Review, September 1977; revised July 1983 as part of NIOSH testimony at OSHA hearing)

1 ppm (1.8 mg/m³), 8-hr TWA; 5 ppm excursion limit (15 min); 29 CFR 1910.1047

Ca;
5 ppm (9 mg/m³) ceiling (10 min/day); <0.1 ppm (0.18 mg/m³), 8-hr TWA;

Ethylene thiourea (Special Hazard Review, October 1978)

None

Ca;
use in encapsulated form in industry; minimize worker exposure

Excavations, development of draft construction safety standards for (Technical Guideline, May 1983)

Many aspects covered under OSHA regulations governing excavations, trenching, and shoring practices in the construction industry (29 CFR 1926, Subpart P)

Many work-practice recommendations concerning safety standards for excavations

Fibrous glass (April 1977)

Nuisance dust PEL applies: 15 mg/m³ total dust; 5 mg/m³ respirable fraction

3 million fibers/m³ TWA (fibers <3.5 μ m in diameter and \geq 10 μ m long); 5 mg/m³ TWA (total fibrous glass)

Fluorides, inorganic (June 1975)

2.5 mg F/m³, 8-hr TWA

2.5 mg F/m³ TWA

NIOSH

Health Effect(s) Considered¹

Comments

2 ppm (n)	Potential for cancer in humans; nervous system, respiratory, cardiovascular, and liver effects	Nursing infants of exposed mothers are at risk
	Potential for cancer in humans; has produced tumors of the liver and lung in animals	Stringent workplace controls and medical monitoring required
	Peritoneal cancer, leukemia, mutagenesis, reproductive effects	Blood monitoring and medical counseling recommended
m in ter	Potential for cancer and teratogenicity in humans; has produced tumors of the liver, thyroid, and lymphatic system in animals	Inform workers of carcinogenic and teratogenic hazards; give special attention to thyroid function tests
om- safety ns	Injury and death	Follow appropriate work-practice guidelines and provide shoring
a. eter g/m ³ s)	Eye, skin, and respiratory effects	NIOSH recommends that this REL also apply to other manmade fibers
	Kidney and bone effects	Urine monitoring required

Fluorocarbon polymers,
decomposition products
of (September 1977)

None

Various recommen-
dations emphasizing good
work practices, engineering
controls, and medical
management

Formaldehyde
(December 1976;
revised in CIB,
April 1981; revised
May 1986 as part of
NIOSH testimony at
OSHA hearing; revised
February 1987 in written
comments to OSHA)

1 ppm, 8-hr TWA; 2 ppm
short-term exposure limit
(15 min);
29 CFR 1910.1048

Ca;
0.016 ppm, 8-hr TWA;
0.1 ppm ceiling (15 min)
(this limit represents the
lowest reliably quantifiable
concentration)

Foundries
(September 1985)

Many aspects covered
under the numerous OSHA
regulations for general
industry (29 CFR 1910)

Various recommendations
emphasizing good work
practices, engineering
controls, and medical
monitoring

Furfuryl alcohol
(March 1979)

50 ppm (200 mg/m³), 8-hr
TWA

50 ppm (200 mg/m³) TWA

Gallium arsenide
(Alert, October 1987)

10 µg As/m³, 8-hr TWA;
29 CFR 1910.1018

Ca;
2 µg As/m³ ceiling (15 min);
see arsenic CD

Glycidyl ethers
(June 1978;
revised in CIB,
October 1978)

All values in ppm (mg/m³):
allyl glycidyl ether (AGE),
10 (45) ceiling;
n-butyl glycidyl ether (BGE),
50 (270), 8-hr TWA;
di-2,3-epoxypropyl ether
(DGE), 0.5 (2.8) ceiling;
(continued on next page)

All are ceiling values
(15 min) in ppm (mg/m³):
AGE, 9.6 (45);
BGE, 5.6 (30);
DGE, 0.2 (1) Ca;
IGE, 50 (240);
PGE, 1 (5)

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published in criteria documents unless otherwise noted.

[†]NIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

[‡]Health effects cited are for humans unless otherwise noted.

Lung effects; polymer
fume fever

Monitor workroom air for
inorganic fluorides and
hydrogen fluoride

Nasal cancer

Implement medical monitoring;
protect skin

Cancer, respiratory
disease, heat-induced
illness, noise-induced
hearing loss, vibration-
induced disorders, eye
injuries, traumatic
and ergonomic injuries

Recommendations limited
to foundries that pour molten
metal into sand molds

Respiratory effects

None

Cancer

Gallium arsenide may dissociate
in the body, releasing gallium
and inorganic arsenic

DGE: Potential for cancer in
humans; has produced skin
tumors in animals. DGE and
other glycidyl ethers: skin
and mucous membrane effects,
sensitization potential,
possible hematopoietic and
reproductive system effects

Possible additive effects
with mixtures; medical
monitoring

When the testimony was presented. NIOSH recommendations were originally
otherwise noted.

**Potential Hazard and
Source for NIOSH
Recommendation***

**OSHA PEL/
Standard**

**REL[†]/Other
Recommendations**

	isopropyl glycidyl ether (IGE), 50 (240), 8-hr TWA; phenyl glycidyl ether (PGE), 10 (60), 8-hr TWA	
Glycol ethers (CIB, May 1983)	2-Methoxyethanol, 25 ppm (80 mg/m ³), 8-hr TWA (Skin); 2-ethoxyethanol, 200 ppm (740 mg/m ³), 8-hr TWA (Skin)	Reduce exposure to low feasible concentration
Grain dust (Technical Guide- line, September 1983; reaffirmed June 1984 as part of NIOSH testimony at OSHA hearing; revised in Arbets Och Halsa, 1988:14 [in press])	Many general aspects (e.g., protective equipment, dust control, etc.) covered under the numerous OSHA regulations for general industry and grain- handling facilities (29 CFR 1910 and 1917); final rule published in Federal Register 52 (251): 49592-49631, Dec. 31, 1987	Various recommendation control of combustible o and ignition sources, m guarding, isolation and outs, bin entry, training, personal protective equi settled grain dust not to exceed 1/4 of an inch to reduce risk of explosi
Hexachloroethane (CIB, August 1978)	1 ppm (10 mg/m ³), 8-hr TWA (Skin)	Ca; reduce exposure to low feasible concentration
Hot environments (June 1972; revised April 1986)	None	Sliding scale limits base on environmental and metabolic heat loads
Hydrazines (June 1978)	All values in ppm (mg/m ³): hydrazine, 1 (1.3), 8-hr TWA (Skin); 1,1-dimethylhydrazine, 0.5 (1.0), 8-hr TWA (Skin); phenylhydrazine, 5 (22), 8-hr TWA (Skin); methylhydrazine, 0.2 (0.35) ceiling	Ca; all are ceiling values (120 min) in ppm (mg/m ³): hydrazine, 0.03 (0.04); 1,1-dimethylhydrazine, (0.15); phenylhydrazine, 0.14 (0.15); methylhydrazine, 0.04 (0.04)

NIOSH

Exposures	Health Effect(s) Considered ^a	Comments
to lowest ion	Male and female reproductive effects, teratogenicity	Prevent skin contact
Recommendations for ble dusts s, machine and lock- ining, and equipment; not in inch explosion	Injury and death, chronic bronchitis, asthma, and chronic obstructive pulmonary disease	Health hazards from exposure to fumigants, pesticides, and grain dust; safety hazards from confined spaces and explosions; reducing exposure to grain dust will decrease exposure to agents that elicit adverse health effects
to lowest ion	Potential for cancer in humans; has produced liver tumors in animals	Prevent skin contact
Heat based and ds	Heat-induced illnesses	Recommendations include acclimatization, strict work practices, protective equipment, and medical monitoring
es mg/m ³): 04); tine, 0.06 0.14 (0.6); 0.04 (0.08)	Potential for cancer in humans; has produced tumors of the lung, liver, blood vessels, and intestines in animals; blood, liver, and skin effects	Blood and urine monitoring and periodic chest X-ray required; bowel examination for workers above age 40

Hydrogen cyanide and cyanide salts (October 1976)	Hydrogen cyanide, 10 ppm (11 mg/m ³), 8-hr TWA (Skin); cyanide, 5 mg CN/m ³ , 8-hr TWA (Skin)	4.7 ppm CN (5 mg CN/m ³) ceiling (10 min)
Hydrogen fluoride (March 1976)	3 ppm, 8-hr TWA	2.5 mg F/m ³ (3 ppm) TWA; 5.0 mg F/m ³ (6 ppm) ceiling (15 min)
Hydrogen sulfide (May 1977)	20 ppm acceptable ceiling; 50 ppm maximum ceiling (10 min)	10 ppm (15 mg/m ³) ceiling (10 min)
Hydroquinone (April 1978)	2 mg/m ³ , 8-hr TWA	0.44 ppm (2 mg/m ³) ceiling (15 min)
Identification system for occupationally hazardous materials (December 1974)	Sections of Hazard Communication (29 CFR 1910.1200) and carcinogen standards may be applicable	Complete designation system for occupationally hazardous materials
Isopropyl alcohol (March 1976)	400 ppm (980 mg/m ³), 8-hr TWA	400 ppm (984 mg/m ³) TWA; 800 ppm (1,968 mg/m ³) ceiling (15 min)
Kepone (January 1976)	None	Ca; 1 µg/m ³ TWA
Ketones (June 1978)	All are 8-hr TWA values in ppm (mg/m ³): acetone, 1,000 (2,400); methyl ethyl ketone, 200 (590); methyl n-propyl ketone, 200 (700); methyl n-butyl ketone, 100 (410); (continued on next page)	All are TWA values in ppm (mg/m ³): acetone, 250 (600); methyl ethyl ketone, 200 (590); methyl n-propyl ketone, 200 (590); methyl n-butyl ketone, 100 (410); methyl n-amyl ketone, 100 (465); methyl isobutyl ketone, 100 (465); (continued on next page)

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²Health effects cited are for humans unless otherwise noted.

HCN/m ³)	Thyroid, blood, and respiratory system effects	Concurrent measurement required for HCN when measuring for cyanide salt; make available trained first-aid personnel and first-aid kits during use; prevent skin and eye contact
n) TWA; n) ceiling	Skin, eye, and airway irritation; bone effects	Periodic pelvic X-ray to detect changes in the osseous system (male workers only) and urine testing required
ceiling	Irritation, severe acute effects involving nervous and respiratory systems	Continuous monitoring required if potential exists for exposure to ≥ 70 mg/m ³ (47 ppm); evacuation required at this level
) ceiling	Eye and skin effects	Special provisions for darkroom use
ion system hazardous	None	Includes definition, safety data sheets, alert symbols, and label statements
m ³) TWA; y/m ³)	Mucous membrane irritation, possible cancer threat in manufacturing process	Stringent work practices and medical monitoring for manufacturing workers required
	Liver cancer, nervous system effects	Liver function testing required
s in ppm 250 (590); e, 200 (590); tone, 150 yl ketone, yl ketone, sobutyl page)	Irritation; liver, kidney, and nervous system effects	Urinalysis required; warn exposed workers about nervous system effects of methyl n-butyl ketone

ed or when the testimony was presented. NIOSH recommendations were originally
s otherwise noted.

Potential Hazard and Source for NIOSH Recommendation*

OSHA PEL/Standard

REL[†]/Other Recommendations

	methyl n-amyI ketone, 100 (465); methyl isobutyl ketone, 100 (410); methyl isoamyI ketone, none; diisobutyl ketone, 50 (290); cyclohexanone, 50 (200); mesityl oxide, 25 (100); diacetone alcohol, 50 (240); isophorone, 25 (140)	ketone, 50 (200); methyl isoamyI ketone, 50 (230); diisobutyl ketone, 25 (140); cyclohexanone, 25 (100); mesityl oxide, 10 (40); diacetone alcohol, 50 (240); isophorone, 4 (23)
Land-based oil and gas well drilling, comprehensive safety recommendations for (Technical Guideline, September 1983; reaffirmed March 1984 as part of NIOSH testimony at OSHA hearing)	Many aspects covered under the numerous OSHA regulations for general industry (29 CFR 1910)	Various recommendations for safe work practices and technologic improvements
Lead, inorganic (January 1973; revised May 1978)	50 $\mu\text{g Pb}/\text{m}^3$, 8-hr TWA; determine by formula for exposures >8 hr; 29 CFR 1910.1025	<100 $\mu\text{g Pb}/\text{m}^3$ TWA; air level to be maintained so that whole blood lead remains $\leq 60 \mu\text{g}/100 \text{ g}$ of whole blood
Lockout/tagout, guidelines for controlling hazardous energy during maintenance and servicing (Technical Guideline, September 1983)	Many aspects covered under OSHA regulations for general industry (29 CFR 1910) and construction standards (29 CFR 1926)	Work-practice recommendations for controlling hazardous energy during maintenance servicing activities
Logging from felling to first haul (July 1976)	None	Extensive work-practice and personal protection recommendations
Melathion (June 1976)	15 mg/m^3 , 8-hr TWA (Skin)	15 mg/m^3 TWA

NIOSH

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Health Effect(s)
Considered¹

Comments

;
);
40);
;
40);

ns for
nts

Injury and death

Many tasks, types of equipment,
and conditions not covered
by existing regulations

ir level
t worker

Kidney, blood, and nervous
system effects

Blood monitoring required

blood
enda-
zardous
ance and

Injury and death

"Energy" is defined in this
document as kinetic energy,
potential energy, electrical
energy, and thermal energy

e
n

Primarily trauma and falls

Institute tetanus toxoid
inoculations and first-aid
programs

Nervous system effects

Prevent skin contact; blood
monitoring required

MMWR

August 26, 1988

Mechanical power presses, injuries and amputations resulting from (CIB, May 1987)

29 CFR 1910.217

Various recommendations for the safe use of power presses, especially those operated by dual palm-button controls

Mercury, inorganic (August 1973)

0.1 mg/m³ acceptable ceiling

0.05 mg Hg/m³, 8-hr TWA

2-Methoxyethanol (see Glycol ethers)

Methyl alcohol (March 1976)

200 ppm (260 mg/m³), 8-hr TWA

200 ppm (262 mg/m³), 800 ppm (1,048 mg/m³) (15 min)

Methyl chloromethyl ether (NIOSH testimony at OSHA hearing, September 1973)

No PEL; cancer-suspect agent; stringent workplace controls, recordkeeping, and medical monitoring required; 29 CFR 1910.1006

Ca; use 29 CFR 1910.1006

4,4'-Methylenebis (2-chloroaniline) (MOCA) (Special Hazard Review, September 1978)

Standard formally revoked by OSHA, August 1975

Ca; 3 µg/m³ TWA (low detectable concentration)

Methylene chloride (March 1976; revised April 1986 in CIB)

500 ppm, 8-hr TWA; 1,000 ppm acceptable ceiling; 2,000 ppm acceptable maximum peak for 5 min in any 2-hr period above the acceptable ceiling for an 8-hr shift

Ca; reduce exposure to feasible concentrations

4,4'-Methylene-dianiline (CIB, July 1986)

None

Ca; reduce exposure to feasible concentrations

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[‡]Health effects cited are for humans unless otherwise noted.

Recommendations for
of mechanical
s, specifically
ed by foot or
tton controls

m^3 , 8-hr TWA

mg/m^3) TWA;
48 mg/m^3) ceiling

910.1006

A (lowest
concentration)

sure to lowest
centration

sure to lowest
centration

Amputations and other
injuries

Central nervous system
and mental effects

Blindness, metabolic
acidosis

Lung cancer

Potential for cancer in
humans; has produced liver
and lung tumors in animals

Potential for cancer in
humans; has produced tumors
of the lung, liver, salivary,
and mammary glands in
animals

Bladder cancer, skin and
liver effects

Injuries and amputations
among press operators occur
with alarming frequency

Emphasize work practices,
sanitation, and environmental
and medical monitoring

None

None

Periodic chest X-ray; blood
and urine testing required

None

Prevent skin contact

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MMWR

published or when the testimony was presented. NIOSH recommendations were originally

unless otherwise noted.

Potential Hazard and Source for NIOSH Recommendation*

OSHA PEL/Standard

REL[†]/Other Recommendations

Methyl parathion
(September 1976)

None

0.2 mg/m³ TWA

Monohalomethanes
(CIB, September 1984)

Methyl chloride: 100 ppm, 8-hr TWA; 200 ppm ceiling; 300 ppm acceptable maximum peak for 5 min in any 3-hr period above the acceptable ceiling for an 8-hr shift.
Methyl bromide: 20 ppm (80 mg/m³) ceiling (Skin).
Methyl iodide: 5 ppm (20 mg/m³), 8-hr TWA (Skin)

Ca;
reduce exposures to methyl chloride, methyl bromide, and methyl iodide to the lowest feasible concentrations

alpha-Naphthylamine
(NIOSH testimony at OSHA hearing, September 1973)

No PEL;
cancer-suspect agent;
stringent workplace controls, recordkeeping, and medical monitoring required;
29 CFR 1910.1004

Ca;
use 29 CFR 1910.1004

beta-Naphthylamine
(NIOSH testimony at OSHA hearing, September 1973)

No PEL;
cancer-suspect agent;
stringent workplace controls, recordkeeping, and medical monitoring required;
29 CFR 1910.1009

Ca;
use 29 CFR 1910.1009

Niax® Catalyst ESN
(joint NIOSH/OSHA CIB, May 1978)

Minimize exposure to Niax® Catalyst ESN and its components and dimethylamino-propionitrile and bis[2-(dimethylamino) ethyl] ether

Minimize exposure to Niax Catalyst ESN and its components, dimethylamino-propionitrile and bis[2-(dimethylamino) ethyl] ether

Nickel carbonyl
(Special Hazard Review, May 1977)

1 ppb (7 µg/m³), 8-hr TWA

Ca;
1 ppb (7 µg/m³) TWA (lowest detectable concentration)

NIOSH

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Health Effect(s) Considered ¹	Comments
Central nervous system effects	Prevent skin contact; blood monitoring required
Potential for cancer in humans; has produced tumors of the kidney, forestomach, and lung in animals; methyl chloride should also be considered a potential teratogen	Prevent skin contact
Bladder cancer	None
Bladder cancer	None
Urological disorders, nervous system effects	Use work-practice and engineering controls to reduce exposure
Lung and nasal cancer	Periodic chest X-ray, pulmonary function testing, and urine monitoring required

MMWR

August 26, 1988

Nickel, inorganic
compounds (May 1977)

1 mg Ni/m³, 8-hr TWA

Ca;
15 µg Ni/m³ TWA

Nitric acid
(March 1976)

2 ppm (5 mg/m³), 8-hr TWA

2 ppm (5 mg/m³) TWA

Nitriles
(September 1978)

Acetonitrile, 40 ppm
(70 mg/m³), 8-hr TWA;
tetramethyl succinonitrile,
0.5 ppm (3 mg/m³), 8-hr
TWA (Skin)

All are TWA values in ppm
(mg/m³):
acetonitrile, 20 (34);
n-butyronitrile, 8 (22);
isobutyronitrile, 8 (22);
propionitrile, 6 (14);
malononitrile, 3 (8);
adiponitrile, 4 (18);
succinonitrile, 6 (20).
All are ceiling values (15 min)
in ppm (mg/m³): acetone
cyanohydrin, 1 (4);
glycolonitrile, 2 (5);
tetramethylsuccinonitrile,
1 (6). When present as
mixtures or with other
sources of cyanide, consider
exposures additive and
calculate environmental limit

4-Nitrobiphenyl
(NIOSH testimony
at OSHA hearing,
September 1973)

No PEL;
cancer-suspect agent;
stringent workplace controls,
recordkeeping, and medical
monitoring required;
29 CFR 1910.1003

Ca;
use 29 CFR 1910.1003

Nitrogen, oxides of
(March 1976)

NO₂, 5 ppm (9 mg/m³)
ceiling; NO, 25 ppm
(30 mg/m³), 8-hr TWA

NO₂, 1 ppm (1.8 mg/m³)
ceiling (15 min);
NO, 25 ppm (30 mg/m³) TWA

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²Health effects cited are for humans unless otherwise noted.

Lung and nasal cancer,
skin effects

Periodic chest X-ray and
pulmonary function testing
required

Dental erosion, nasal/lung
irritation

Prevent skin and eye contact;
periodic chest X-ray required

Hepatic, renal, respira-
tory, cardiovascular,
gastrointestinal, and
nervous system effects

Periodic chest X-ray and
pulmonary function testing
required; make trained personnel
and first-aid kits available
during use; prevent skin and
eye contact

Potential for cancer in
humans; has produced
bladder tumors in animals

None

Respiratory effects,
blood effects

Pulmonary function testing
required

When the testimony was presented. NIOSH recommendations were originally
otherwise noted.

Potential Hazard and Source for NIOSH Recommendation*

OSHA PEL/ Standard

REL[†]/Other Recommendations

Nitroglycerin and ethylene glycol dinitrate (EGDN) (June 1978)

Nitroglycerin, 2 mg/m³, (0.2 ppm) ceiling (Skin);
EGDN, 1 mg/m³ (0.2 ppm) ceiling (Skin)

0.1 mg/m³ ceiling (20 min) recommended limit for either substance alone or mixtures

2-Nitronaphthalene (CIB, December 1976)

None

Ca;
reduce exposure to lowest feasible concentration

2-Nitropropane (CIB, April 1977; revised October 1980 in joint OSHA/NIOSH Health Hazard Alert)

25 ppm (90 mg/m³), 8-hr TWA

Ca;
reduce exposure to lowest feasible concentration

N-Nitrosodimethylamine (NIOSH testimony at OSHA hearing, September 1973)

No PEL;
cancer-suspect agent;
stringent workplace controls, recordkeeping, and medical monitoring required;
29 CFR 1910.1016

Ca;
use 29 CFR 1910.1016

Noise (August 1972)

90 dBA, 8-hr TWA

85 dBA TWA; 115 dBA ceiling

Organic solvents, (CIB, March 1987)

Numerous organic solvents covered under
29 CFR 1910.1000

REs exist for approximately 92 chemicals and mixtures that may be defined as organic solvents; see entry for specific solvent of interest

Organotin compounds (November 1976)

0.1 mg/m³, 8-hr TWA

0.1 mg Sn/m³ TWA

NIOSH

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Health Effect(s)
Considered^a

Comments

Circulatory system effects

Prevent skin contact

Bladder cancer

Compound metabolizes to beta-naphthylamine, a known carcinogen

Potential for cancer in humans; has produced liver tumors in rats

Conduct medical monitoring with specific emphasis on liver function tests

Potential for cancer in humans; has produced tumors of the liver, kidney, lung, and nasal cavity in animals

None

Hearing damage

None

Neurotoxic effects including narcosis, anesthesia, CNS depression, respiratory arrest; impaired psychomotor function, manual dexterity, coordination, or body balance; peripheral neuropathy and toxic encephalopathy

None

Eye, skin, liver, nervous system, and heart effects

Periodic chest X-ray, blood and urine monitoring, eye tests, heart examination, and nervous system testing required; prevent skin and eye contact

MMWR

August 26, 1983

Paint and allied
coating products,
manufacture of
(September 1984)

Many aspects covered
under the numerous
OSHA regulations for
general industry
(29 CFR 1910)

Various recommendations for
the handling of raw materials
and finished products, disper-
sion of pigment or resin par-
ticles, filling, laboratory func-
tions, and thinning, tinting,
and shading

Parathion
(June 1976)

0.1 mg/m³, 8-hr TWA (Skin)

0.05 mg/m³ TWA

Pentachloroethane
(CIB, August 1978)

None

Handle with caution in the
workplace

Pesticides,
manufacture and
formulation of
(July 1978)

Follow current OSHA PELs or NIOSH RELs; institute stringent
work-practice and medical monitoring requirements

Phenol
(July 1976)

5 ppm (19 mg/m³), 8-hr
TWA (Skin)

5.2 ppm (20 mg/m³) TWA;
15.6 ppm (60 mg/m³)
ceiling (15 min)

Phenyl-beta-
naphthylamine
(CIB, December 1976)

None

Ca;
reduce exposure to lowest
feasible concentration

Phosgene
(February 1976)

0.1 ppm (0.4 mg/m³),
8-hr TWA (Skin)

0.1 ppm (0.4 mg/m³) TWA;
0.2 ppm (0.8 mg/m³) ceiling
(15 min)

Polychlorinated
biphenyls
(September 1977)

42% chlorine, 1 mg/m³,
8-hr TWA (Skin);
54% chlorine, 0.5 mg/m³,
8-hr TWA (Skin)

Ca;
1 µg/m³ TWA (the minimum
reliably detectable
concentration using the
recommended sampling and
analytical methods)

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noted.

[‡]Health effects cited are for humans unless otherwise noted.

ions for aterials disper- in parti- func- nting,	Injury; a wide range of toxicities considered	Paint and allied coating products include paints, varnishes, lacquers, stains, putties, and paint and varnish removers
	Nervous system effects	Prevent skin contact; blood monitoring required
a the	Central nervous system effects, possible liver and kidney effects	Exposures should be minimized because of structural similarity to carcinogenic chloroethanes
ringent	Wide range of toxicities considered; cancer; nervous and reproductive system effects	Blood monitoring required for some groups; warn workers of reproductive effects for some compounds; prevent skin contact
WA;	Skin, eye, central nervous system, liver, and kidney effects	Prevent skin and eye contact
west	Bladder cancer	Compound metabolizes to beta-naphthylamine, a known carcinogen
TWA; celling	Respiratory effects	Pulmonary function testing and periodic chest X-ray required
imum	Potential for cancer in humans; has produced tumors of the liver and pituitary gland and leukemias in animals; skin, liver, and reproductive system effects	Blood testing required; warn female workers of child-bearing age and nursing mothers of potential adverse effects; prevent skin contact

or when the testimony was presented. NIOSH recommendations were originally
otherwise noted.

Potential Hazard and Source for NIOSH Recommendation*

OSHA PEL/Standard

REL[†]/Other Recommendations

Polychlorinated biphenyls from electrical equipment fires or failures (CIB, February 1986)

42% chlorine, 1 mg/m³, 8-hr TWA (Skin); 54% chlorine, 0.5 mg/m³, 8-hr TWA (Skin)

Ca; reduce exposure to lowest feasible concentration

Precast concrete products (Technical Guideline, June 1984)

Some aspects covered under the numerous OSHA regulations for general industry (29 CFR 1910)

Various recommendations for safe work practices and worker training

beta-Propiolactone (NIOSH testimony at OSHA hearing, September 1973)

No PEL; cancer-suspect agent; stringent workplace controls, recordkeeping, and medical monitoring required; 29 CFR 1910.1013

Ca; use 29 CFR 1910.1013

Radon progeny in underground mines (October 1987)

MSHA standard is 1.0 WL with annual cumulative exposure of 4.0 WLM; see 30 CFR 57.5037 through 30 CFR 57.5047

Ca; 1.0 WLM/year with average workshift concentration $\leq 1/12$ of 1.0 WL (or 0.083 WL)

Refined petroleum solvents (July 1977)

Petroleum distillates (naphtha), 2,000 mg/m³ (500 ppm), 8-hr TWA; Stoddard solvent, 2,900 mg/m³ (500 ppm), 8-hr TWA

Kerosene, 100 mg/m³ TWA; all other solvents, 350 mg/m³ TWA, 1,800 mg/m³ ceiling (15 min)

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Health Effect(s) Considered^a

Comments

Potential for cancer in humans; has produced tumors of the liver and pituitary gland and leukemias in animals; skin, liver, and reproductive system effects

Fire-related incidents involving PCBs have resulted in widespread contamination of buildings with PCBs, and in some cases, with PCDFs and PCDDs, including TCDD. Emergency response personnel, maintenance or cleanup workers, or building occupants may be exposed to these compounds

Injury and death

Equipment, conditions, and many of the tasks specific to the industry are not covered under the existing regulations

Potential for cancer in humans; has produced tumors of the liver, skin, and stomach in animals

None

Lung cancer

REL of 1.0 WLM/year is upper limit of cumulative exposure, and every effort shall be made to reduce exposures to the lowest possible levels

Eye, nose, and throat irritation; dermatitis; nervous system effects

Blood and urine monitoring required; action level for petroleum ether, rubber solvent, naphtha is 200 mg/m³ TWA; action level for mineral spirits and Stoddard solvent is 350 mg/m³ TWA; action level for kerosene is 100 mg/m³ TWA; prevent skin contact

Silica,
crystalline
(November 1974)

Respirable quartz,
250 mppcf or 10mg/m³
%SiO₂ + 5 %SiO₂ + 2

Respirable free silica,
50 µg/m³ TWA

Sodium hydroxide
(September 1975)

2 mg/m³, 8-hr TWA

2 mg/m³ ceiling (15 min)

Styrene
(September 1983)

100 ppm, 8-hr TWA;
200 ppm acceptable
ceiling; 600 ppm maximum
ceiling (5 min in 3 hr)

50 ppm (213 mg/m³) TWA;
100 ppm (426 mg/m³) ceiling
(15 min)

Sulfur dioxide
(February 1974;
revised May 1977 as
part of NIOSH testimony
at OSHA hearing)

5 ppm (13 mg/m³), 8-hr
TWA

0.5 ppm (1.3 mg/m³) TWA

Sulfuric acid
(June 1974)

1 mg/m³, 8-hr TWA

1 mg/m³ TWA

2,3,7,8-Tetrachloro-
dibenzo-*p*-dioxin
(TCDD) (CIB, January
1984)

None

Ca;
reduce exposure to lowest
feasible concentration

1,1,1,2-Tetrachloro-
ethane
(CIB, August 1978)

None

Handle with caution in the
workplace

1,1,2,2-Tetrachloro-
ethane
(December 1976;
revised in CIB,
August 1978)

5 ppm (35 mg/m³), 8-hr TWA
(Skin)

Ca;
reduce exposure to
lowest feasible concentration

Tetrachloroethylene
(July 1976;
revised January
1978 in CIB)

100 ppm, 8-hr TWA; 200 ppm
acceptable ceiling; 300 ppm
maximum ceiling (5 min in
3 hr)

Ca;
minimize workplace exposure
concentration

*Dates in parentheses indicate when the NIOSH recommendation was published or when the
published in criteria documents unless otherwise noted.

[†]NIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

[‡]Health effects cited are for humans unless otherwise noted.

Chronic lung disease (silicosis)	Periodic chest X-ray and pulmonary function testing required
Respiratory irritation	Prevent skin and eye contact
Nervous system effects; eye and respiratory system irritation; reproductive system effects	Prevent skin contact; warn workers of possible adverse reproductive effects
Respiratory effects	Pulmonary function testing required
Pulmonary irritation	Prevent skin and eye contact
Potential for cancer in humans; has produced tumors at many sites in animals; chloracne	None
Central nervous system effects; possible liver and kidney effects	Exposures should be minimized because of structural similarity to carcinogenic chloroethanes
Potential for cancer in humans; has produced tumors of the liver in animals; liver, gastrointestinal, and nervous system effects	Prevent skin contact; blood monitoring required
Potential for cancer in humans; has produced tumors of the liver in animals	None

the testimony was presented. NIOSH recommendations were originally noted.

Potential Hazard and Source for NIOSH Recommendation*

OSHA PEL/Standard

REL[†]/Other Recommendations

Thiols: n-alkane mono thiols, cyclohexanethiol, and benzenethiol (September 1978)

Butylmercaptan (1-butane-thiol), 10 ppm (35 mg/m³), 8-hr TWA; ethylmercaptan (1-ethanethiol) 10 ppm (25 mg/m³) ceiling; methylmercaptan (1-methanethiol), 10 ppm (20 mg/m³) ceiling

All values are 15 min ceilings in ppm (mg/m³):
1-methanethiol, 0.5 (1.0);
1-ethanethiol, 0.5 (1.3);
1-propanethiol, 0.5 (1.6);
1-butanethiol, 0.5 (1.8);
1-pentanethiol, 0.5 (2.1);
1-hexanethiol, 0.5 (2.4);
1-heptanethiol, 0.5 (2.7);
1-octanethiol, 0.5 (3.0);
1-nonanethiol, 0.5 (3.3);
1-decanethiol, 0.5 (3.6);
1-undecanethiol, 0.5 (3.9);
1-dodecanethiol, 0.5 (4.1);
1-hexadecanethiol, 0.5 (5.3);
1-octadecanethiol, 0.5 (5.9);
cyclohexanethiol, 0.5 (2.4);
benzenethiol, 0.1 (0.5).
Control mixtures of thiols by calculating equivalent concentrations

o-Tolidine (August 1978)

None

Ca;
20 µg/m³ ceiling (60 min)

o-Tolidine-based dyes (joint NIOSH/OSHA Health Hazard Alert, December 1980)

None

Ca;
handle with caution in the workplace; minimize exposure

Toluene (January 1974)

200 ppm, 8-hr TWA; 300 ppm acceptable ceiling; 500 ppm maximum ceiling (10 min)

100 ppm (375 mg/m³), 8-hr TWA; 200 ppm (750 mg/m³) ceiling (10 min)

Toluene diisocyanate (July 1973; revised, see Diisocyanates, September 1978)

0.02 ppm (0.14 mg/m³) ceiling

0.005 ppm (0.036 mg/m³) TWA; 0.02 ppm (0.14 mg/m³) ceiling (10 min)

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Health Effect(s)
Considered^a

Comments

Irritation; eye, skin,
blood, and nervous
system effects

Blood and urine monitoring
required; prevent skin contact

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Bladder cancer, nasal
irritation

Urine testing required; quarterly
urine monitoring recommended;
prevent skin contact

Bladder cancer

Substitute less toxic dyes
wherever possible

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Central nervous system
depressant

None

Respiratory effects

Periodic chest X-ray, blood
tests, pulmonary function
testing required

1,1,1-Trichloroethane (July 1976; revised August 1978 in CIB)	350 ppm (1,900 mg/m ³), 8-hr TWA	350 ppm (1,910 mg/m ³) c (15 min); action level set 200 ppm (1,091 mg/m ³) T handle with caution
1,1,2-Trichloroethane (CIB, August 1978)	10 ppm (45 mg/m ³), 8-hr TWA (Skin)	Ca; reduce exposure to lowest feasible concentra
Trichloroethylene (July 1973; revised in Special Hazard Review, January 1978)	100 ppm, 8-hr TWA; 200 ppm acceptable ceiling; 300 ppm maximum ceiling (5 min in 2 hr)	Ca; 25 ppm TWA
Trimellitic anhydride (CIB, February 1978)	None	Handle in the workplace extremely toxic substance
Tungsten and cemented tungsten carbide (September 1977)	None	Insoluble tungsten, 5 mg W/m ³ TWA; soluble tungsten, 1 mg W/m ³ TWA; dust of cemented tungsten carbide (containing >2% cobalt), 0.1 mg Co/m ³ TV dust of cemented tungsten carbide (containing >0.3% nickel), 15 µg Ni/m ³ TWA
Ultraviolet radiation (December 1972)	None	For spectral region of 315-400 nm: for periods sec, 1.0 mW/cm ² ; for per ≤1,000 sec, 1,000 mW-se (1.0 J/cm ²). For spectral region of 200-315 nm: oc criteria document

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[†]NIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

[‡]Health effects cited are for humans unless otherwise noted.

(m³) ceiling
set at
(m³) TWA;

Central nervous system,
liver, and cardiovascular
effects

Medical warning of possible
congenital abnormalities
required; structurally similar
to carcinogenic chloroethanes

centration

Potential for cancer in
humans; has produced liver
tumors in animals; central
nervous system effects

None

place as an
stance

Potential for cancer in
humans; has produced liver
tumors in animals; central
nervous system effects

Warn workers of hazards;
25 ppm level can be achieved by
use of existing engineering
control technology

Pulmonary edema; immuno-
logic sensitization;
irritation of pulmonary
tract, eyes, nose, and skin

Minimize workplace levels

Lung and skin effects

Pulmonary function testing and
periodic chest X-ray required

ngsten
>2%
(m³) TWA;
ngsten
>0.3%
'TWA

Skin and eye effects

Avoid skin and eye contact

of
periods >1,000
or periods
W-sec/cm²
ctral
m: consult

ed or when the testimony was presented. NIOSH recommendations were originally

otherwise noted.

Potential Hazard and Source for NIOSH Recommendation*	OSHA PEL/ Standard	REL [†] /Other Recommendations
Vanadium (August 1977)	Vanadium pentoxide dust, 0.5 mg/m ³ ceiling; vanadium pentoxide fume, 0.1 mg/m ³ ceiling; ferrovanadium, 1 mg/m ³ , 8-hr TWA	Vanadium compounds, 0.05 mg V/m ³ ceiling (15 min); metallic vanadium and vanadium carbide, 1 mg V/m ³ TV
Vibration syndrome (CIB, March 1983)	None	Redesign jobs to minimize use of vibrating hand tools; redesign powered hand tools to minimize vibration
Vinyl acetate (September 1978)	None	4 ppm (15 mg/m ³) ceiling (15 min)
Vinyl chloride (March 1974; reaffirmed June 1974 as part of NIOSH testimony at OSHA hearing)	1 ppm, 8-hr TWA; 5 ppm ceiling (15 min); 29 CFR 1910.1017	Ca; lowest reliably detectable concentration
Vinyl halides (September 1978)	None except for vinyl chloride	Ca; vinyl halides to be controlled as specified for vinyl chloride in 29 CFR 1910.1017, with eventual goal of zero exposure
Waste anesthetic gases and vapors (March 1977)	None for substances when used as anesthetic agents	Halogenated anesthetic agents, 2 ppm ceiling (1 hr); nitrous oxide, 25 ppm TWA during periods of use

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	Health Effect(s) Considered ¹	Comments
(5 min); vane- m ³ TWA	Eye, skin, and lung effects	Pulmonary function testing and periodic chest X-ray required
nize the ools; d tools	Vibration syndrome; adverse circulatory and neural effects in the fingers	None
ing	Irritation	None
ble	Liver cancer	Liver function testing required
controlled chloride with exposure	Vinyl chloride has produced liver cancer in humans; other vinyl halides have produced liver and kidney tumors in animals	Vinyl halides include vinyl chloride, vinylidene chloride, vinyl bromide, vinyl fluoride, and vinylidene fluoride monomers
c agents, TWA	Reproductive system effects and audio-visual performance decrements	Halogenated anesthetic agents include chloroform, enflurane, fluroxene, halothane, methoxy- flurane, and trichloro- ethylene; advise workers of potential effects; document abnormal outcomes of pregnancies of workers or spouses

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August 26, 1988

Welding, brazing,
and thermal cutting
(April 1988)

Many aspects are covered
under the following
regulations: general industry
(29 CFR 1910), construction
(29 CFR 1926), ship repairing
(29 CFR 1915), ship building
(29 CFR 1916), longshoring
(29 CFR 1917)

Existing RELs for specific
chemical and physical agents
are applicable; consider
these RELs upper bound
of exposure; implement
recommendations emphasizing
good work practices,
engineering controls,
medical monitoring

Xylene
(May 1975)

100 ppm (435 mg/m³),
8-hr TWA

100 ppm (434 mg/m³)
200 ppm (868 mg/m³)
(10 min)

Zinc oxide
(October 1975)

5 mg/m³, 8-hr TWA
(as ZnO fume)

5 mg ZnO/m³ TWA;
15 mg ZnO/m³ ceiling

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^bNIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

^cHealth effects cited are for humans unless otherwise noted.

specific
physical agents
consider
boundaries
element
is emphasizing
ices,
controls, and
ing

(g/m³) TWA;
(g/m³) ceiling

VA;
ceiling (15 min)

Cancer, respiratory disease,
heat-induced illness, noise-
induced hearing loss, eye
injuries, traumatic and
ergonomic injuries

None

Central nervous system
depressant; respiratory
irritation

None

Metal fume fever

None

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less otherwise noted.

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